 National Transportation Safety Board FACTUAL REPORT AVIATION		NTSB ID: CHI05MA011		Aircraft Registration Number: N709CK	
		Occurrence Date: 10/20/2004		Most Critical Injury: None	
		Occurrence Type: Accident		Investigated By: NTSB	
Location/Time					
Nearest City/Place Lake Michigan		State	Zip Code	Local Time 2029	Time Zone CDT
Airport Proximity: Off Airport/Airstrip		Distance From Landing Facility:			
Aircraft Information Summary					
Aircraft Manufacturer Boeing		Model/Series 747-132		Type of Aircraft Airplane	
Revenue Sightseeing Flight: No			Air Medical Transport Flight: No		
Narrative					
<p>Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:</p> <p>HISTORY OF FLIGHT</p> <p>On October 20, 2004, about 2029 central daylight time, a Boeing 747-132, N709CK, operated by Kalitta Air, LLC, (Kalitta Air) as flight 825, received substantial damage following a separation and loss of the number one engine while climbing through about 15,000 feet mean sea level (MSL) over Lake Michigan. The 14 CFR Part 121 non-scheduled domestic cargo flight was operating on an instrument flight rules flight plan. Night visual meteorological conditions were reported at the time of the accident. The two pilots, one flight engineer, and two flight mechanics were uninjured. The flight departed from Chicago O'Hare International Airport, Chicago, Illinois, at 2010, and was en route to John F. Kennedy International Airport, New York, New York, when it diverted to Detroit Metropolitan Wayne County Airport (DTW), Detroit, Michigan, where it landed without further incident.</p> <p>The flight crew did not report any abnormal conditions prior to the engine separation. Following the engine separation, the flight crew diverted to DTW where a landing was accomplished with normal operation of the leading edge devices and trailing edge flaps.</p> <p>The airplane, a Boeing 747-132, had the number one engine, a Pratt & Whitney (P&W) JT9D-7A, separate from the pylon and fall into Lake Michigan as the airplane was climbing through 15,000 feet MSL. The flight crew reported that as the airplane was climbing to flight level 180, they heard a loud bang, the airplane yawed to the left, and the number one engine cockpit indications showed that the engine had lost all power. A visual inspection by the crew of the number one engine to check for damage revealed the pylon was still in place, but the engine was missing. The airplane diverted to DTW and landed without further incident. After the airplane landed, the examination of the pylon revealed the forward portion was damaged with the entire forward bulkhead including the forward engine mounts separated from the airplane. The examination The examination also revealed that the top of the mount rails and circumferentially inclusive of the four mount bolts remained attached to the aft mount on the pylon.</p> <p>AIRCRAFT INFORMATION</p> <p>According to Kallita Air maintenance records the engine that separated from the airplane was a Pratt & Whitney model JT9D-7A, serial number (S/N) 662253. This engine had been installed 94.1 hours and 23 cycles prior to the event at which time the high pressure turbine (HPT) and the turbine exhaust case (TEC) modules were installed on the engine. At the time of the event, the installed HPT module had accumulated 5,727.6 hours and 1,287 cycles since United Airlines had overhauled it in September 1996. Kalitta Air maintenance records also show that particular HPT module had been swapped in and out of two of their other engines to facilitate other maintenance. According to Kalitta, they inspected the HPT module under the authority of their 14 CFR Part 121</p>					
FACTUAL REPORT - AVIATION					

National Transportation Safety Board

FACTUAL REPORT**AVIATION**

NTSB ID: CHI05MA011

Occurrence Date: 10/20/2004

Occurrence Type: Accident

Narrative (Continued)

certificate. They stated that they did not do anything to the HPT module other than a visual inspection in accordance with the maintenance manual. Kalitta Air obtained the HPT module installed on a JT9D engine, S/N 662570 from Tradewinds, a Florida-based aviation broker, and inducted it into their engine maintenance program in 2003. Tradewinds had purchased the engine from AeroTurbine who had purchased the engine as part of a group of 13 from General Electric Commercial Aviation Services (GECAS). GECAS leased the engine and the airplane on which it was installed to Polar Air Cargo. According to Kalitta Air records, the engine was removed for stagger; but according to Polar Air Cargo, the engine was removed from the airplane in 1998 because the airplane was being scrapped because of expense. GECAS stated that they had intended to send engine SN 662570 to GE's engine maintenance facility at Cardiff, Wales, to be parted out, however the engine was never sent to Wales. GECAS had engine SN 662570 inspected by an independent consultant who determined the engine was unserviceable because of problems in the number three bearing area. According to Polar Air Cargo, at the time the airplane and engines were taken out of service, they had been having problems with the number four engine that was SN 662570. Engine SN 662570 was in storage from 1998 when it was removed from the airplane until 2003 when it was acquired by Kalitta Air. According to the maintenance records, there was no maintenance accomplished to the engine including preservation during that five year period.

WRECKAGE AND IMPACT INFORMATION

In June 2005, portions of the turbine exhaust case and low pressure turbine case were recovered from Lake Michigan, and then in August 2005, the bulk of the engine, except for the low pressure turbine (LPT), was recovered from a debris field that extended approximately 600 feet on the lake bottom at a depth of approximately 270 feet. The engine was located approximately 46.42 nautical miles on a magnetic course of 81 degrees from ORD at the following coordinates: 42 degrees 04.958 minutes North, 86 degrees 52.566 minutes West. Recovery of the engine, TEC, and LPT case was conducted by American Diving and Salvage of Chicago, Illinois. The pieces of the TEC and LPT case were shipped to the National Transportation Safety Board Materials (NTSB) Laboratory for examination. The main part of the engine was shipped to P & W's Middletown, Connecticut, facility for disassembly under the supervision of the NTSB.

The piece of the turbine exhaust case that remained on the number one engine pylon consisted of the section of the case from just forward of the forward mount rail to just aft of the rear mount rail axially to either side of the through-the-rail mount bolts. The body of the turbine exhaust case was recovered from the lake with the LPT case attached to the front flange, but was missing a section at the top of the case that corresponded with the piece of the case that remained attached to the engine pylon. There were several circumferential cracks in the case wall in front of the front mount rail and in back of the rear mount rail. The circumferential fractures did not progress along any of the weld seams. The turbine exhaust duct, or center body of the turbine exhaust case, was missing and only 3 of the 12 struts remained attached to the case. The three struts that remained attached to the turbine exhaust case and the three stub ends of missing struts were buckled. The National Transportation Safety Board Materials Laboratory report stated that all of the fractures were consistent with overload and that there was no evidence of fatigue or a material defect.

TESTS AND RESEARCH

The disassembly and examination of the engine revealed the high pressure turbine (HPT) second stage turbine disk was missing a 180-degree arc of the rim and blade posts. Additionally, the front face of the second stage turbine disk had circumferential rubs and grooves from contact with the second stage turbine vane inner support and the inner feet of the second stage turbine vanes. Examination of the engine identified that the released section of the HPT 2nd stage disk was uncontained through the forward portion of the LPT case between the 4 and 6 o'clock locations. The fan case

National Transportation Safety Board

FACTUAL REPORT**AVIATION**

NTSB ID: CHI05MA011

Occurrence Date: 10/20/2004


Occurrence Type: Accident


Narrative (Continued)


did not have any indications of having sustained separated fan blade impact damage. Further, the examination of the number one bearing balls showed that they had no rotational damage. Additionally, one thrust reverser jackscrew drive that was recovered and the drive motor was at the head end. Most of the second stage turbine vanes were broken or missing. There were two clusters of 15 and 28 second stage turbine vanes that remained in place in the HPT case. The vanes did not have any indications of burning or hot gas erosion. The cluster of 15 vanes that was located in the upper right quadrant of the engine had a groove worn into the rear face that got progressively deeper in the counter-clockwise direction. Additionally, the grooves in the vane feet would only line up if the vanes were tilted.

During the metallurgical examination of the second-stage turbine vane retaining bolt, the visual examination of the bolts revealed cracks in the head-to-shank fillet radius. No bolt fractures were attributed to the observed cracking in the head-to-shank fillet radius. Additionally, the energy dispersive spectroscopy (EDS) analysis of the anti-gallant coating on the threads revealed the presence of silver in addition to molybdenum. The required anti-gallant coating on the second stage turbine vane retaining bolts contains a combination of molybdenum disulfide and lead oxide, FelPro-C200. According to P&W's metallurgist, further examination of the coating on the threads revealed the silver was in a flake form that was consistent with a silver-based thread lubricant such as Silver Goop. According to the JT9D Engine Manual, Silver Goop is not authorized in the HPT area of the engine including the second stage turbine vane retaining bolts, but is specified in the JT9D LPC.

Boeing and P&W made a joint assessment of the separation of the engine from the airplane specifically looking at why the turbine exhaust case broke up releasing the engine rather than the pylon fuse pins breaking. The point of this request was in concern to the fact that the turbine exhaust case had undergone a repair that had replaced the entire forward section of the case to improve the containment capability of the case. The joint assessment determined that the engine structure broke up before the fuse pins failed because the engine structure, specifically the forward portion of the LPT case, had been compromised with the uncontained liberation of the second-stage turbine disk rim followed by the extreme unbalance of the missing rim section and the torque loads developed by the clashing of the low-pressure turbine blades and vanes. The Boeing and P&W assessment determined that the unbalance loads generated by the missing section of the second stage turbine disk rim at climb power were 3.6 - 6.6 times greater than the separation of a full fan blade. The metallurgical examination of the turbine exhaust case showed that the metal had torn away from the area of the circumferential weld. The Boeing and P&W assessment determined the unbalance loads were so severe that they could have caused the break up of the turbine exhaust case in either the original or modified configuration.

 National Transportation Safety Board FACTUAL REPORT AVIATION		NTSB ID: CHI05MA011			
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Landing Facility/Approach Information					
Airport Name	Airport ID:	Airport Elevation Ft. MSL	Runway Used NA	Runway Length	Runway Width
Runway Surface Type:					
Runway Surface Condition:					
Approach/Arrival Flown: NONE					
VFR Approach/Landing: None					
Aircraft Information					
Aircraft Manufacturer Boeing		Model/Series 747-132		Serial Number 20247	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Amateur Built Acft? No	Number of Seats: 7	Certified Max Gross Wt. LBS		Number of Engines: 4	
Engine Type: Turbo Fan	Engine Manufacturer: Pratt & Whitney	Model/Series: JT9D-7A		Rated Power: 46150 LBS	
- Aircraft Inspection Information					
Type of Last Inspection Continuous Airworthiness	Date of Last Inspection 10/2004	Time Since Last Inspection 94.1 Hours		Airframe Total Time 93548.7 Hours	
- Emergency Locator Transmitter (ELT) Information					
ELT Installed?/Type	ELT Operated?	ELT Aided in Locating Accident Site?			
Owner/Operator Information					
Registered Aircraft Owner Kalitta Air, LLC		Street Address 818 Willow Run Airport			
		City Ypsilanti	State MI	Zip Code 48198	
Operator of Aircraft Kalitta Air, LLC		Street Address 818 Willow Run Airport			
		City Ypsilanti	State MI	Zip Code 48198	
Operator Does Business As:			Operator Designator Code: KCSA		
- Type of U.S. Certificate(s) Held:					
Air Carrier Operating Certificate(s): Flag Carrier/Domestic					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 121: Air Carrier					
Type of Flight Operation Conducted: Non-scheduled; International; Cargo					
<div>FACTUAL REPORT - AVIATION</div> <div>Page 2</div>					


 National Transportation Safety Board FACTUAL REPORT AVIATION		NTSB ID: CHI05MA011			
		Occurrence Date: 10/20/2004			
		Occurrence Type: Accident			
First Pilot Information					
Name		City		State	Date of Birth
On File		On File		On File	On File
					Age
					45
Sex: M	Seat Occupied: Left	Occupational Pilot?		Certificate Number: On File	
Certificate(s): Airline Transport; Commercial					
Airplane Rating(s): Multi-engine Land					
Rotorcraft/Glider/LTA:					
Instrument Rating(s):					
Instructor Rating(s):					
Current Biennial Flight Review?					
Medical Cert.: Class 1		Medical Cert. Status:		Date of Last Medical Exam: 07/2004	
- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night
Total Time	10015	4000			
Pilot In Command(PIC)	8000				
Instructor					
Instruction Received					
Last 90 Days	180				
Last 30 Days	73				
Last 24 Hours	8				
Seatbelt Used? Yes		Shoulder Harness Used? Yes		Toxicology Performed? No	
				Second Pilot? Yes	
Flight Plan/Itinerary					
Type of Flight Plan Filed: IFR					
Departure Point		State	Airport Identifier	Departure Time	Time Zone
CHICAGO		IL	ORD	2010	CDT
Destination		State	Airport Identifier		
NEW YORK		NY	JFK		
Type of Clearance:					
Type of Airspace:					
Weather Information					
Source of Wx Information:					
Unknown					

 National Transportation Safety Board FACTUAL REPORT AVIATION			NTSB ID: CHI05MA011		
			Occurrence Date: 10/20/2004		
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Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
ORD	1956	CDT	655 Ft. MSL	NM	Deg. Mag.
Sky/Lowest Cloud Condition: Clear			Ft. AGL	Condition of Light: Night	
Lowest Ceiling: Overcast			1700 Ft. AGL	Visibility: 10 SM	Altimeter: 30.12 "Hg
Temperature: 11 °C		Dew Point: 8 °C	Weather Conditions at Accident Site: Visual Conditions		
Wind Direction: 10		Wind Speed:	Wind Gusts:		
Visibility (RVR): Ft.		Visibility (RVV) SM			
Precip and/or Obscuration: No Obscuration; No Precipitation					

Accident Information					
Aircraft Damage: Substantial		Aircraft Fire: None		Aircraft Explosion: None	

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL	
First Pilot				1	1	
Second Pilot				1	1	
Student Pilot						
Flight Instructor						
Check Pilot						
Flight Engineer				1	1	
Cabin Attendants						
Other Crew				2	2	
Passengers						
- TOTAL ABOARD -				5	5	
Other Ground						
- GRAND TOTAL -				5	5	

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	Occurrence Date: 10/20/2004	
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Administrative Information		
<p>Investigator-In-Charge (IIC)</p> <p>Mitchell F. Gallo</p>		
<p>Additional Persons Participating in This Accident/Incident Investigation:</p> <p>Thomas L Weber Federal Aviation Administration Detroit, MI</p> <p>Mark H Smith The Boeing Company Seattle, WA</p> <p>Douglas J Zabawa Pratt & Whitney East Hartford, CT</p> <p>Heath Nicholl Kalitta Air Ypsilanti, MI</p> <p>Jeff Plantz United Airlines Elk Grove Village, IL</p>		
<p>FACTUAL REPORT - AVIATION</p> <p>Page 5</p>		